

*Berger
Exhibit*

#415

MACKENZIE DELTA GAS DEVELOPMENT SYSTEM

VOLUME 4

PLANT PROCESS AND OPERATIONS

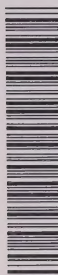
Prepared by:

GULF OIL CANADA LIMITED

IMPERIAL OIL LIMITED

SHELL CANADA LIMITED

ALBERTA
LIBRARY



3 1761 12064636 9



Digitized by the Internet Archive
in 2025 with funding from
University of Toronto

<https://archive.org/details/31761120646369>

MACKENZIE DELTA GAS DEVELOPMENT SYSTEM

VOL. 4

PLANT PROCESS AND OPERATIONS

October 1974

TABLE OF CONTENTS

	<u>PAGE</u>
I. SUMMARY	1
II. LOCATION	3
A. TWO-PLANT CONCEPT AND CHOICE OF LOCATION	3
B. PLOT PLANS	5
III. PLANT DESIGN CONSIDERATIONS	6
A. PROCESS	6
1. Description	6
2. Flow Diagrams	7
3. Plant By-Products	7
4. Feed-Gas Analyses	8
5. Material Balance	8
B. ENVIRONMENTAL	9
1. Air	9
2. Water	10
3. Noise	11
4. Solid Wastes	12
5. Emergencies	12
IV. PHYSICAL DESIGN AND ARCTIC CONSTRUCTION	15
A. PHYSICAL DESIGN FOR THE ARCTIC ENVIRONMENT	15
1. Protection of the Environment	15
2. Protection of Facilities	17
B. MODULE CONCEPT	19
C. CONSTRUCTION LOGISTICS	21
1. Construction Centres and Transportation	21

2.	Construction Schedule	23
3.	Manpower Schedule	24
D.	DISCUSSION OF CANADIAN CONTENT	25
V.	SUPPORT FACILITIES	26
A.	PERSONNEL QUARTERS	26
B.	STORAGE AREAS	26
C.	PLANT UTILITIES	27
1.	Electric Power	27
2.	Water Supply and Treatment	27
3.	Air	28
4.	Heat	28

I. SUMMARY

The gas produced in the Mackenzie Delta would have to be processed to meet the specifications and conditions for long-distance pipeline transportation. This volume describes the plants that would be required for this purpose.

The Applicants' proposal is for two plants, one to be located in the Richards Island area, one at Parsons Lake. Both plants would have the same basic process. First, the raw gases would be separated into liquid and gas, then the gas would be dried to remove condensation water, and subjected to low temperatures to meet the hydrocarbon dew-point requirements. Finally, it would be compressed and cooled to delivery conditions.

Liquid hydrocarbons might be used as fuel, returned to formation for storage, or fractionated into saleable products as the need should arise.

For the preliminary design the Taglu plant was sized for 1 BCF per day of which 500 MMCF would come from each of the Taglu and Niglintgak areas. The Parsons Lake plant was sized for 500 MMCF per day of gas from that area.

Process and support equipment would be designed with particular attention to the need to protect the environment. For further protection, the quality of the air and water would be monitored regularly.

A major design feature of the plant is the modular construction concept, in which large packages of equipment would be constructed in a southern location and shipped complete to the plant site. This approach would greatly reduce construction work on the actual sites.

The larger modules, up to 800 tons, would be built in Vancouver and transported to the site by ocean barge around Point Barrow. Smaller modules would be manufactured in Calgary and Edmonton, assembled in Hay

River and transported north via the Mackenzie River. This split system would both take advantage of a more widespread labour and manufacturing-shop pool, and distribute the transportation load more uniformly.

As the plants would be in isolated areas remote from normal living accommodation, they have been designed for minimum manpower, although not for completely unattended operations. Operating and maintenance personnel would need suitable living quarters at the plant sites. With the help of an architectural consultant, the Applicants have sought to plan a living area that would be socially complete and personally attractive in order to encourage long-term employment.

Support facilities for both plants and living quarters would be designed to provide the high degree of safety and continuity needed for this type of operation in the arctic.

II. LOCATION

A. TWO-PLANT CONCEPT AND CHOICE OF LOCATION

The Applicants propose two plants to process gas in the Mackenzie Delta area, one for each area of major gas accumulations. These are centred in the Richards Island and the Parsons Lake areas, which are about 50 miles apart.

In the Richards Island area, the Taglu plant-site was selected for the following reasons:

1. It is close to the geographical centre of known fields in the outer delta area.
2. It is close to a navigable channel. Water transport is essential, both for initial construction and for servicing during the operations phase.
3. It is on the highest land in the area, and would thus be less susceptible to damage from flood or storm surge than alternative nearby locations.
4. It is close to adequate year-round sources of potable water.
5. It is in one of the less sensitive wildlife areas in the outer delta region, and would lie south of the revised boundary of the Kendall Island Bird Sanctuary.

In the Parsons Lake area, the plant site would be located on the east side of Parsons Lake for the following reasons:

1. It is close to the geographical centre of known gas reserves in the area.
2. It would minimize the length of the gathering systems needed for the Parsons Lake field proper.

3. It is about 5 miles from the Eskimo Lakes, which provide a navigable waterway to the Beaufort Sea.
4. Adequate land is available for a nearby jet-aircraft strip.
5. It avoids any sensitive wildlife area.

B. PLOT PLANS

Figure 1 is a preliminary plot plan of the proposed Taglu plant, showing the locations of accommodation facilities, docks, airstrip and plant flare.

Figure 2 shows the plant layout in more detail. These figures are based on data prepared by the plant consultant, Stearns-Roger Canada Limited, and represent typical plot plans subject to revision for each specific plant.

III. PLANT DESIGN CONSIDERATIONS

A. PROCESS

1. Description

Each plant would be required to process incoming raw-gas feed by removing excess water and liquid hydrocarbons, then compressing and cooling the product to meet the following sales-gas specifications:

Delivery Pressure	1680 psig
Delivery Temperature	+30°F
Hydrocarbon Dewpoint	+25°F at 850 psig +20°F at 900 psig +10°F at 1000 psig 0°F at 1050 psig -10°F at 1100 psig
Water Dewpoint	-10°F at 1680 psig

The process scheme at Taglu and Parsons Lake would include inlet separation and measurement of gas and liquid hydrocarbons, then chilling of the gas to -20°F at 1080 psia. This treatment would reduce the hydrocarbon content to the dewpoint specification. Treatment with ethylene glycol and separation of the glycol-water would bring the water content down to meet the water-dewpoint specification. The gas would then be compressed to the 1680 psig pressure level, and chilled by air exchange and propane refrigeration to meet the delivery requirements.

The major equipment needed would be heat exchangers, separation vessels, gas compressors for gas and propane, and gas-turbine drivers for the compressors.

The present design scheme would provide for gas from the Niglintgak field to be processed at the Taglu location, but separately from the Taglu stream because of the difference in liquid-hydrocarbon content.

(The Niglintgak gas would not have to be treated for liquid hydrocarbons.) Niglintgak gas would undergo inlet separation to remove water, followed by chilling to -20°F and contact with ethylene glycol to achieve the required water dewpoint. The gas would then be compressed and cooled by air exchange and propane refrigeration to meet pipeline pressure and temperature specifications.

Major process support facilities at each plant would include a propane refrigeration system to supply the refrigerant to chill the gas, and a glycol regeneration system to supply the glycol for removing the water.

2. Flow Diagrams

Figures 3, 4 and 5 are the basic flow diagrams for the main process, refrigeration and glycol-regeneration facilities at the Taglu plant. Figure 6 is the comparable figure for the main process at Parsons Lake.

3. Plant By-Products

The major by-product at each plant would be the hydrocarbon liquid removed from the gas to enable it to reach dewpoint. At the Taglu plant, some of this liquid might be used in the plant fuel system; the rest would be injected to a suitable underground formation until an oil pipeline should provide a sales outlet. At the Parsons Lake plant, the condensate might be split into major components such as propane, butane, aviation and diesel fuels, for use in nearby areas or as plant fuel. Any surplus would be injected to a suitable underground formation.

The other by-product is water, which would be injected to a suitable underground formation.

4. Feed-Gas Analyses

Table I shows feed-gas analyses for the three major gas streams now available for processing: Taglu, Parsons Lake and Niglintgak.

5. Material Balance

Material balances for the Taglu and Parsons Lake plants are shown respectively in Tables II and III. They are based on the design feed gas analyses of Table I under normal operating conditions. Stream numbers relate to Figures 3 and 6.

B. ENVIRONMENTAL

1. Air

a) Emissions Control

The Mackenzie Delta gas plants would process sweet gas; i.e., gas that does not contain hydrogen sulphide. The plants would be designed so that normally no vapours would be emitted. Safety requirements would call for a flare system, for pressure relief in case any failure of plant equipment should result in vessel overpressure. Gas would then be released to the flare system, but the plant emergency shut-down system would immediately cut off raw gas production to minimize flaring. Such conditions would be rare in any event, and the flared volumes small. By far the largest volume of flared gas would be released during plant start-up, when flaring would be necessary until the residue gas was suitable for introduction into the sales pipeline. The flow rate, however, would be kept at the lowest practical level for establishing process operations. Procedures would be developed to minimize the flare rate at start-up by bringing on trains in sequence, and recycling gas through the process as far as possible.

b) Contaminants

The flare system installed in the plants will be designed to operate in a smokeless manner by ensuring complete combustion of hydrocarbons. Present design concepts include air blowers or a stack-head design to provide 100 per cent excess air at critical flaring ratios. If flares kept occurring, plant throughputs would be reduced. The system would be designed to avoid flaring liquid hydrocarbons.

A potential problem would be the heat released at the flares and turbine exhausts. The design would ensure that the ground beneath

these heat sources was adequately insulated by gravel or other means, to protect the permafrost against thawing.

c) Quality Monitoring

The quality of the air around the gas plants would be continuously monitored. Analytical instruments would check wind velocity and direction, air temperature, humidity, rainfall, snowfall, and the presence of contaminants such as sulphur dioxide. The information would be transmitted via telemetry to the plant control rooms. Either portable or stationary instruments would be used to monitor ambient conditions.

Gas-detection equipment would be installed in the process areas to announce the presence of gas and initiate appropriate remedial action.

2. Water

a) Process Water

Gas-processing plants in the Mackenzie Delta would be designed to produce a minimum amount of waste-water effluents. No major cooling-water and steam-generation equipment would be included. The only waste water from the process would be the produced water from the wells and the water removed during dehydration of the gas. This water would require only to be filtered before being injected to a suitable underground formation, through a disposal well located near each plant.

b) Sewage

Liquid wastes arising from washrooms, laundries and kitchen facilities would undergo secondary treatment to provide water acceptable for discharge to a nearby watercourse. Sewage treatment facilities would be provided to handle both construction and operating stages, at expected rates of 8400 Imperial gallons per day during construction and 3700 Imperial

gallons per day during normal plant operation. Wastes from satellite facilities would be handled by chemical toilets at these stations and transported regularly to the central plant for treatment with the plant wastes. The sewage-treatment system considered is the mechanical activated sludge type, consisting of biological reduction of the sewage in an aeration tank, followed with solids removal by chemical coagulants and a clarifier, and final filtration of the stream. The treated water from this type of system would be suitable for release to a natural watercourse. Excess activated sludge from the aeration tanks would be incinerated.

c) Surface Water

The plant areas would be laid out and graded to provide natural drainage of runoff water to catch basins, where the quality might be checked before the water was released. Facilities would also be provided for any oil-skimming and treatment that might be necessary.

d) Quality Monitoring

The quality of injection water would be monitored regularly for suspended-solid content, to ensure good performance of the injection wells. Treated water from the sewage plant would be tested regularly for biological oxygen demand (BOD) and suspended solids, by trained technicians in the laboratory facilities provided at the plants.

3. Noise

To reduce noise levels in and around the plant to acceptable limits, sound-attenuation devices would be installed on all equipment. Plant equipment would be designed to meet a noise-emission standard of 65dBA at the plant lease boundaries, and 85dBA inside the plant at a distance of three feet.

4. Solid Wastes

Refuse from the camp, and the waste sludge produced by the sewage-treatment plant, would be incinerated and the ashes buried in a designated landfill site. Solid waste that would have to be disposed of is estimated at one ton per day (180 cubic feet) from each plant during construction, and half that amount during operation.

5. Emergencies

a) General Design of Fire-Prevention and Alarm System

The plants would be equipped to provide safe, automatically controlled processing facilities. Operations would be monitored from central control rooms which would also monitor gas, fire and smoke detectors placed throughout the plants and at other points such as storage areas, dock areas and living quarters.

Standard manual fire-protection and -extinguishing equipment, carbon-dioxide units and fire blankets, would be placed at strategic locations inside the plants.

b) Plant Emergency and Disaster Control Plans

Each plant would prepare a manual containing the plans to be implemented in case of any emergency or disaster in the field or at the plant, such as fire, explosion, flooding, line break, oil spill or other contingency.

The manual would include

General Organization

There would be an outline of plant and company management, describing the function, responsibilities and duties of each person in an emergency.

Plant and Field Protection Organization

This section would detail the organization and responsibilities of plant and field supervisory personnel for protecting personnel and facilities in an emergency.

Emergency Procedure

This section would describe the emergency control procedure with the data required to augment it, methods for controlling fires, and emergency shut-down procedures, together with locations of all shut-down controls.

Inventory and Location of Fire-Fighting Equipment

Each piece of equipment would be located on a plot plan of the plant, and described by make, model and capability.

Emergency Vehicles

In arctic plants of this size, emergency vehicles would vary with the season. Certain pieces of mobile equipment such as trucks, snowmobiles and boats would be designated for emergency service. This section would describe these vehicles, their equipment and locations.

Employee Listings

This section would name all personnel who might be required in an emergency situation, with their locations at any given time and how they could be reached for communication.

Aircraft and Supply-Boat Listings

Transportation in the Delta would be mainly by aircraft and boat. This section would list the names and call numbers of all aircraft and boats that were available to the plant in emergency, and the means of communicating with them.

Camp and Cluster Listings

The locations and capacities of other nearby locations that had shelter and equipment would be listed here.

Second-Line Shelter

Possible second-line shelters in the area that might be used would be listed here, with their contact and communication procedures.

Communications

The normal communications equipment would be described by capability and location, together with emergency communication equipment. For example, the radio equipment set-up would have a standby set at the broadcast tower some distance from the main plant.

Individual Plans and Procedures for Disasters

The methods for reporting such emergencies as spills and gas leaks would be included here. Spill contingency plans would be coordinated by a special committee set up for that purpose.

IV. PHYSICAL DESIGN AND ARCTIC CONSTRUCTION

A. PHYSICAL DESIGN FOR THE ARCTIC ENVIRONMENT

In a normal environment, the design and construction of gas facilities such as those contemplated for the Mackenzie Delta would be a large and complex undertaking, but not particularly unusual. However, the unique conditions in the arctic require unusual construction techniques to solve engineering problems that are not encountered elsewhere. These techniques concern foundation design and modular construction. Special attention would be given to protecting the environment from the effects of the facilities, and the facilities from the effects of the environment.

1. Protection of the Environment

a) Gravel Roads and Pads

The plant sites are located in areas of continuous permafrost that may be ice-rich near the surface. Vegetation and underlying organic material form an insulating blanket, which limits the depth of thaw to about two feet. The surface layer must in no case be damaged if degradation of the underlying permafrost is to be prevented.

Detailed design parameters for permanent all-weather gravel roads and pads are covered elsewhere in this application.

b) Winter Roads

Although permanent gravel roads would serve plant facilities, vehicles might sometimes have to visit temporary sites, or travel across the tundra during the construction phase before permanent roads had been built. In winter, snow roads would be built or the vehicles would travel

on frozen streams. For summer travel off permanent roads, helicopter or hovercraft transportation would be provided.

c) Disposal of Construction Waste

Construction of gas plants and related facilities in the Delta would generate wastes of several different types. The construction itself would produce both combustible and noncombustible solid wastes, hydrocarbons and other volatile liquids, and some contaminated water. Camps housing the construction workers would generate combustible and noncombustible solids and sewage. These wastes would be treated as follows:

Solid, Combustible Waste

Solid, combustible construction waste would be burned in a suitable incinerator. Noncombustible residue would be combined with other noncombustible trash and disposed of as described below.

Solid, Noncombustible Waste

Solid, noncombustible waste would be compacted and buried in suitable landfill sites. All solid wastes would be incinerated before burial.

Liquid, Combustible Waste

Liquid, combustible waste (used lube oil, contaminated diesel fuel and/or gasoline, solvents, paints and thinners, etc.) would be consumed in a suitable incinerator.

Sewage and Contaminated Water

Any contaminated water generated by construction activities would be commingled with construction-camp sewage and delivered to the sewage-treatment plant. Sewage would be treated in a biological oxidation unit and filtered.

2. Protection of Facilities

a) Personnel Quarters

All maintenance and operating personnel would be quartered at the plant sites.

The quarters, described more fully elsewhere in this application, would be entirely self-sustaining. Critical utility and life-support systems would be duplicated to provide maximum reliability.

b) Natural-Gas Processing Plants

Experience in northern Alberta and British Columbia has provided the Applicants with a good understanding of how to protect the plants from the environment. Basically, most equipment would be located in closed, heated buildings. As for the housing, utility systems would be designed for maximum reliability.

Individual parts of the process units (modules or groups of modules) might be interconnected by insulated, heated corridors also functioning as utilidors. These would enable men to move freely among the various parts of each plant, or between plant and housing complex, without being exposed to the weather.

Portions of each plant, which would be located in heated buildings, would be designed for normal ambient temperatures. Special attention would be given to the design of exterior equipment exposed to the arctic environment.

c) Off-site Installations

Off-site installations would be designed much like the plant and are described elsewhere in this application.

Temporary or emergency accommodations would be provided at each remote site. These facilities would be used during start-up, when

operating problems occurred, when maintenance was necessary, or when weather prevented the day crews from returning to the main housing area.

The operating areas would be covered by a two-way radio communications network, and all vehicles away from the main housing area would be able to maintain radio contact. Each crew supervisor would be required to know the whereabouts of all his men when they were not in the main housing area. Crews leaving the main housing area would carry adequate survival gear for emergencies.

Other safety procedures would become better defined as the project progressed. Procedures would be well enough developed before start-up that, with the facilities provided, there would be no question of personnel or equipment safety.

B. MODULE CONCEPT

All surface facilities required to produce gas from the Mackenzie Delta would be prefabricated and shipped to the arctic in large packages called modules. These structures, weighing up to 800 tons each, would be sized to fit ocean-going barges roughly 76 feet wide and 250 feet long. Barges would be loaded in summer, and the fleet would sail in time to move around Point Barrow when the arctic pack ice moved away from the coast. Special crawler-tractors would move the modules from the barges to the foundations.

Modular construction is a concept commonly applied to the engineering of offshore structures. It had not been extensively used on land until the advent of major construction in the arctic.

Constructing facilities of the type and size planned for the Mackenzie Delta entirely on site would require a labour force of over 700 skilled craftsmen. Such a force would not be practical in the arctic, as workmen would have to be transported from the south to augment the small northern manpower pool. The logistics problems, and the expense of supporting such an operation for possibly two years, would be extreme. Doing as much of the work as practical in a southern location, where manpower is more plentiful, would produce the best results.

In spring the Delta is subject to flooding that would affect the Taglu plant. (The Parsons Lake plant is about 100 feet above sea level and would escape the floods.) In summer the Taglu terrain is for the most part water-logged tundra. In the winter there is no appreciable daylight, and temperatures can fall as low as -60°F . These climatic problems would make construction very difficult unless the packaging

concept were applied. Once the modules were placed on their piles and enclosed, most of the other work could be done indoors where heat and light would be available.

The major cause for environmental concern in the arctic is man and his actions. The amount of sewage and solid waste to be disposed of, the risk of fire, the possibility of damage to the tundra, the effects on animals - all are in direct ratio to the number of men present. The modular construction concept, by reducing the number of men needed in the area, would thus protect the environment from undue disturbance.

C. CONSTRUCTION LOGISTICS

1. Construction Centres and Transportation

Major module fabrication would be carried out in the Vancouver area, which is accessible by rail and sea both for receipt of heavy materials and for shipment of large plant modules to the Mackenzie Delta. A large labour pool is available in the area, and the mild climate would permit good productivity. Fifty to sixty acres for assembly and storage would be needed to construct the modules for the two plants. There would have to be access to an ocean-barge landing area for module loading. Indoor shops would be provided for subassembly work.

Smaller modules requiring less labour would be assembled in Alberta shops for rail shipment to the river-barge staging area at Hay River.

The route of the ocean-going barges would be from Vancouver to the Mackenzie Delta plant site via the Gulf of Alaska, Bering Sea, Arctic Ocean around Point Barrow, and Beaufort Sea to the river delta. At the mouth of the river, in Kugmallit Bay, sea-going tugs would be replaced by river tugs and the barges moved to a shallow area suitable for lightering. Enough general cargo would be removed to reduce the draft on the sea-going barges to less than 7 feet (depending on the river water-level in the particular year). Draft could be reduced to about 4 feet if only one 800-ton module were left aboard a 76' x 250' barge. A preliminary survey indicates that 7-foot draft vessels could be moved from the Kugmallit Bay area to the Taglu site on Richards Island.

Modules for the Parsons Lake plant would continue around the Tuktoyaktuk peninsula into Eskimo Lakes. Water depths along this route could support fully loaded ocean-going barges, with a minimum of dredging.

General bulk materials, equipment, and the small modules would be transported from Edmonton by rail to Hay River. Where earlier arrival at Taglu and Parsons would be beneficial, and materials were suitable for truck shipment, handling them by truck to Fort Simpson would get them to the Delta about a week sooner because of the earlier spring break-up. From Hay River (or Fort Simpson), river barges would move cargoes to the Mackenzie Delta plant site and staging areas.

Figure 7 is a map showing the possible barge routes from the construction centres at Vancouver and Hay River to the Mackenzie Delta area.

The large plant modules would be handled by self-powered transporters. The use of two 500-ton capacity transporters would permit the hauling of a module of 800 tons with a degree of flexibility in actual module weight distribution (up to 500 tons on a single lift point), a track bearing load of less than $3\text{-}1/2$ tons/ft², and the assured ability to negotiate grades up to 10 per cent slope. This design permits the use of two transporters to handle the loading of all plant modules onto water transport, and their unloading and setting at the plant sites.

At Vancouver each module would be moved from its near-water fabrication location to barge deck by two 500-ton transporters. It would then be positioned on the barge and welded down on the truss pedestals. The transporters would be shipped with the last module loaded. The procedure would be reversed at the unloading dock, the modules would be positioned over their pile foundations and set in place. After the last module had been set, the transporters could be returned to their places of origin, barged to another work area, or dismantled and flown out if necessary.

2. Construction Schedule

The attached construction schedule, Figure 8, indicates the proposed timing of major activities in the construction of the two plants to meet a 1979 on-stream date. The schedule is based on the contractor's beginning to procure equipment by July 1, 1975.

Plant-site gravel for constructing the pad and dikes would need to be excavated and stockpiled at the source (or sources) during the summer of 1975. Equipment and manpower for hauling it to the sites and placing it would have to be precommitted and mobilized with enough lead time for work to begin early in 1976 and finish while winter roads were still adequate (before about mid-April). Gravel movement and placing would necessarily be carried out round the clock. Personnel housing and associated facilities at the main plant site would be erected on piling during the summer of 1977, after which construction would be housed at this location.

Module fabrication in Vancouver would begin in early 1976 and continue until early 1978, when the modules would have to be loaded on barges and sailed to a staging area on the northern coast of Alaska. There the barges would await breakup of the Beaufort Sea ice before proceeding to the Mackenzie Delta.

Offsite construction at the main plant and clusters would begin in the early summer of 1976. After the plant modules had arrived from the west coast via the Arctic Ocean, they would be unloaded and set on foundations, and interfacing would begin. On mechanical completion, the testing and commissioning of equipment would begin for plant start-up by mid-1979.

3. Manpower Schedule

Included on Figure 8 is an estimate of manpower required for the major phases of the work. A labour force of various construction craft tradesmen, peaking at approximately 340, would be needed for module fabrication in Vancouver. A great many of the skilled tradesmen would be employed by local subcontractors operating under the direction of the Management Contractor. The peak construction labour force at the plant sites would be about 350 men.

D. DISCUSSION OF CANADIAN CONTENT

In all phases of the engineering and construction of the plant Canadian content would be an important consideration. Canadian companies would always be approached first for contracting work.

In evaluating equipment and material, Canadian origin would be considered in addition to suitability, price and deliverability.

V. SUPPORT FACILITIES

A. PERSONNEL QUARTERS

The Applicants would want to give their employees on tours of duty at the arctic plants a living area that was socially complete and personally attractive, to encourage long-term employment. The facilities would be appealing enough to be viewed by employees as a highly desirable fringe benefit.

The living quarters would have to be designed to provide flexibility, both for the residents in terms of activity centres and spacial areas to move in and out of, and for management in the daily supervision of the operation.

An architectural consultant has prepared a design for personnel housing at each plant that would achieve these goals. Figures 9 and 10 illustrate the current design concept in its present stage of development.

B. STORAGE AREAS

Temporary storage of construction supplies and equipment would be provided in the form of a containerized warehouse and yard storage areas. This warehouse could be used again in the permanent facilities, or dismantled and removed when construction was complete.

Permanent tankage would be provided at each plant to store heating oil, glycol, diesel fuel, gasoline and water. Pressure vessels also would be provided for storing liquid-condensate product. The Parsons Lake plant might have additional storage facilities to handle propane, diesel and aviation fuels. All liquid storage tanks would be enclosed by dikes to contain any spills or leaks.

C. PLANT UTILITIES

Each process plant would need a number of auxiliary utility services. They include the following systems:

1. Electric Power

Electric power would be needed in the operations phase for electric motor-drivers, lighting loads, and miscellaneous heating duties. It would be supplied by on-site generators driven by gas turbines.

A diesel-engine driven power-plant would be installed in the initial construction phase to supply the lighting load for the construction camp, including sleeping quarters, commissary, sewage plant, incinerator and water-treatment plant. In the operations stage this power plant would be instrumented to supply emergency lighting loads for the plant, personnel accommodation, sewage plant, incinerator, and water-treatment plant, and critical plant loads during start-up.

2. Water Supply and Treatment

Water would be pumped from the adjacent channel of the Mackenzie River for the Taglu plant and from local deep-water sources for the Parsons Lake plant. An estimated 9,000 to 10,000 gallons a day would be needed during construction, and about half that amount for operations. It would be treated to potable standards for the use of personnel and to supply service and makeup water to the process. Water storage would be provided in the order of 20,000 barrels, to allow for periods of high turbidity at the source and to meet other needs such as fire-fighting. A water-pumping station would be installed upstream of the dock facility at Taglu, and at the water source at Parsons Lake.

3. Air

Air-compression systems would be installed to provide service air for plant maintenance and instrument air for the process.

4. Heat

There would be two major heat systems. Process heat would be provided by a heating-oil system tied into waste-heat units on the gas-turbine exhausts.

Space heating would be supplied by a glycol-water system similarly heated by gas-turbine exhaust waste-heat units.

Personnel housing would be heated by either the same hot glycol-water stream or some alternative means such as direct-fired air or electrical heating elements.

TABLE I

MACKENZIE DELTA JOINT GAS PLANNING
PLANT AND PROCESS FEED GAS ANALYSES

<u>COMPONENT</u>	<u>TAGLU</u> <u>MOL %</u>	<u>PARSONS LAKE</u> <u>MOL %</u>	<u>NIGLINTGAK</u> <u>MOL %</u>
Nitrogen	0.12	1.74	0.15
Carbon Dioxide	0.26	2.82	1.17
Methane	92.81	88.15	98.18
Ethane	3.63	3.78	.41
Propane	1.13	1.56	.08
Iso Butane	0.23	0.26	.01
Normal Butane	0.27	0.45	
Iso Pentane	0.12	0.16	
Normal Pentane	0.09	0.14	
Hexane	0.05	0.15	
Heptane	0.07	0.18	
Octane	0.11	0.11	
Nonane	0.05	0.19	
Decane	0.10	0.06	
Undecane	0.08	0.25	
Dodecane	0.27		
Benzene	0.04		
Toluene	0.11		
Xylene	0.19		
Aromatic "A"	0.04		
Cyclo Hexane	0.07		
Naphthene "A"	0.16		
	100.00	100.00	100.00

TABLE II
MACKENZIE DELTA JOINT GAS PLANNING
PLANT AND PROCESS FEED GAS ANALYSES
MATERIAL BALANCE - TAGLIU PLANT

STREAM NUMBERS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Component	Taglu Inlet	Taglu Vapor	Taglu Inlet Liquid	Chiller Separator Vapor	Chiller Separator Liquid	Stabilizer Feed Tank Vapor	Stabilizer Feed	Stabilizer Reflux	Stabilizer Total Overhead	Stabilizer Net Overhead	Stabilizer Bottoms	Recycle Chiller Vapor	Recycle Chiller Liquid	Taglu Residue Vapor	Nightgak Inlet	Taglu- Nightgak Residue Vapor
N ₂	1,585	1,581	4	1,579	2	5	1		1					1,585	1,961	3,546
CO ₂	3,432	3,361	71	3,329	32	39	64	10	74	64		88	15	3,432	15,450	18,882
C ₁	1,223,688	1,217,327	8,131	1,213,964	3,563	7,937	3,757	274	4,031	3,757		10,806	888	1,223,658	1,296,256	2,522,216
C ₂	47,927	46,715	1,212	46,046	669	1,770	1,311	417	1,728	1,311		1,244	637	47,927	53,341	101,268
C ₃	14,920	13,969	931	13,404	585	190	1,245	1,245	2,571	1,326		508	1,008	14,920	1,056	15,976
n-C ₄	3,036	2,682	334	2,449	233	35	352	1,103	1,650	567	5	95	487	3,031	152	3,183
i-C ₄	3,565	3,026	539	2,667	359	39	859	2,205	3,027	822	37	103	758	3,528		3,528
i-C ₅	1,585	1,180	405	920	260	13	652	239	305	46	606	3	56	979		979
n-C ₅	1,188	830	333	604	226	9	575	93	106	13	562	1	21	626		626
n-C ₆	1,660	327	333	165	162	3	492				840		3	168		168
C ₇	924	284	640	82	202	2	840				840		2	84		84
C ₈	1,453	243	1,210	34	209	1	1,418				1,418		1	35		35
C ₉	660	57	603	4	53		656				656			4		4
C ₁₀	1,321	59	1,262	2	57		1,319				1,319			2		2
C ₁₁	1,056	26	1,030		26		1,056				1,056					
C ₁₂	3,565	18	3,547		18		3,565				3,565					
Benzene	528	187	341	66	121	1	461	2			461		1	67		67
Toluene	1,453	292	1,161	52	240	2	1,399				1,399		2	54		54
Xylene	2,508	252	2,256	19	233	1	2,488				2,488		1	20		20
Arom. "N"	528	21	507	527	1		527				527		3	1		1
Cyclohexane	924	362	562	142	220	3	779				779		4	145		145
Naph "N"	2,113	581	1,532	149	432	4	1,960				1,960		4	153		153
Total Nois/Day	1,320,589	1,293,600	26,989	1,285,678	7,922	8,854	26,057	5,608	13,495	7,887	18,170	12,854	3,887	1,302,419	1,320,589	2,623,008
lbs/Hr	1,033,829	936,996	96,833	921,401	15,595	6,757	105,671	12,087	22,288	10,201	95,470	10,374	6,584	908,359	906,323	1,844,682
No1 Wt	18.79	17.38	86.11	17.20	47.25	18.31	97.33	51.73	39.64	31.04	126.10	19.37	40.65	17.29	16.47	16.88
MMSCF/D @ 60°F																
14.73 PSIA	500.00	489.78		486.78		3.35			5.11	2.98		4.86		493.12	500.00	993.12
SP GR @ 60°F			0.686		0.567		0.712	0.546			0.766		0.489			
USG/M @ 60°F			282.4		56.0		296.7	44.23			249.51		26.93			
Temp (°F)	85	85	85	-20	-20	85	85	95	147	95	515	0	0	25	85	25
Press (PSIA)	1,100	1,100	1,100	1,080	1,080	500	500	245	245	240	249	480	480	1,700	1,100	1,700

TABLE III

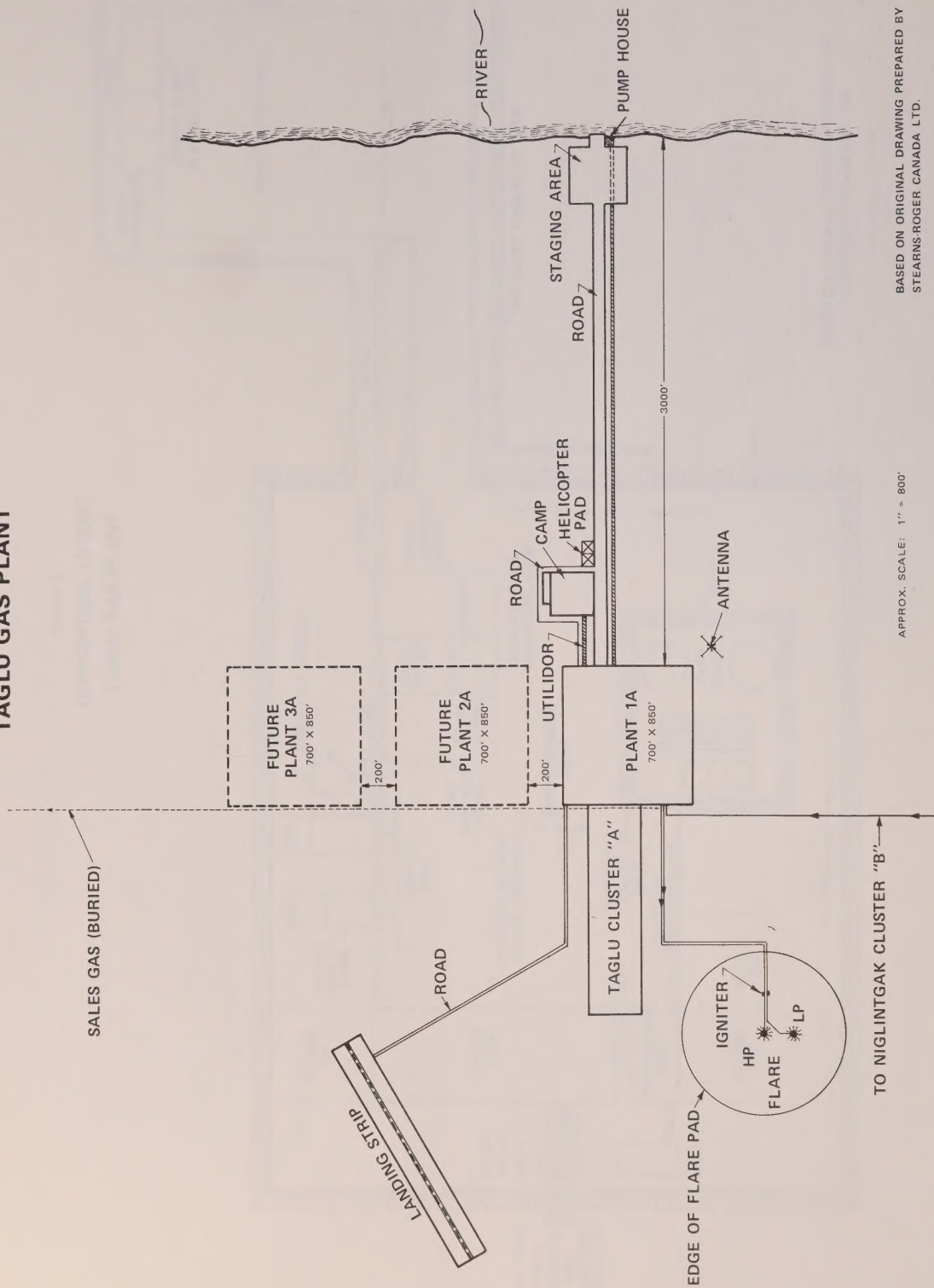
MACKENZIE DELTA JOINT GAS PLANNING
PLANT AND PROCESS FEED GAS ANALYSES

MATERIAL BALANCE - PARSONS LAKE PLANT

STREAM NUMBERS		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Component		Plant Inlet	Plant Inlet Vapor	Plant Inlet Liquid	Chiller Separator Vapor	Chiller Separator Liquid	Feed Tank Vapor	Feed To Fract.	Fract. Ovid.	Fract. Bottoms	Rich Vapor	Rich Liquid	Deethan. Ovid.	Deethan. Bottoms	Deprop. Ovid.	Deprop. Bottoms	Reinj. Gas	Reinj. Liquid	Sales Gas	
N ₂	CO ₂	22,978	22,937	41	22,864	73	107	7	7	7	110	4	4	4			114		22,978	
		37,241	36,814	427	35,916	898	874	451	451	451	960	365	365	365			1,325		37,241	
		1,164,100	1,158,541	5,559	1,148,438	10,103	12,797	2,865	2,865	2,865	13,946	1,716	1,716	1,716			15,662		1,164,100	
		49,918	48,952	966	47,039	1,913	1,351	1,528	1,528	1,528	1,584	1,295	1,255	1,255			2,839	40	49,918	
		20,601	19,576	1,025	17,507	2,069	715	2,379	2,379	2,379	731	2,363	38	2,325	2,285	40	769	2,325	20,601	
		1-C ₄	3,433	3,128	305	2,537	591	100	796	792	4	97	795	21	795	21	774	97	795	3,429
		n-C ₄	5,943	5,253	690	3,980	1,273	162	1,801	1,607	194	138	1,631	4	1,631	4	1,627	138	1,631	5,749
		i-C ₅	2,113	1,704	409	1,059	645	41	1,013	14	2	53	53	53	53	36	2	53	1,114	
		n-C ₅	1,849	1,419	430	790	629	32	1,027	5	1,022	36	36	36	36	36	36	2	36	827
		C ₆	1,981	1,171	810	392	779	17	1,572	14	1,572	17	17	17	17	17	17	1	17	409
		C ₇	2,377	974	1,403	178	796	9	2,190	9	1,572	2	17	9	9	9	9	9	9	187
C ₈	C ₉	1,453	352	1,101	30	322	2	1,421	1,421	2,190	2	2	2	2	2	2	2	2	32	
		2,509	344	2,165	14	330	1	2,494	2,494	2,494	1	1	1	1	1	1	1	1	15	
		792	59	733	1	58		791	791	791										
		3,301	131	3,170	1	130		3,300	3,300	3,300										
Total Mols./Day		1,320,589	1,301,355	19,234	1,280,746	20,609	16,208	23,635	9,648	13,987	17,569	8,287	3,378	4,909	2,350	2,559	20,947	4,909	1,306,602	
Lbs/Hr		1,071,773	1,008,637	63,136	975,010	33,627	14,246	82,517	14,920	67,597	15,115	14,051	3,462	10,589	4,308	6,281	18,577	10,589	1,004,176	
Mol. Wt.		19.48	18.60	78.78	18.27	39.16	21.09	83.79	37.06	116.04	20.60	40.70	24.60	51.74	44.0	58.91	21.30	51.74	18.45	
MMSCF/Day		500	492.70		484.90		6.14		3.65		6.65		1.28				7.93		494.67	
*Water (lbs/hr)																				
@ 14.73 PSIA & 60°F		805.30	780.00	25.30	3.23	776.77	10.30	15.00	15.00	-	0.44	-	-	-	-	-	0.44	-	3.67	
SP GR @ 60°F				0.64		0.50		0.65		0.71		0.57		0.55	0.51	0.58		0.55		
USGPM @ 60°F				197		135		253.50		191.10		49.20		38.60	17.10	21.50		38.60		
Temp °F		85	85	85	-20	-20	85	85	100	438	0	0	-10	219	100	195	100	100	25	
Press. PSIA		1,100	1,100	1,100	1,070	1,070	500	500	180	195	470	470	430	445	200	200	1,070	1,720	1,700	

9/30/74

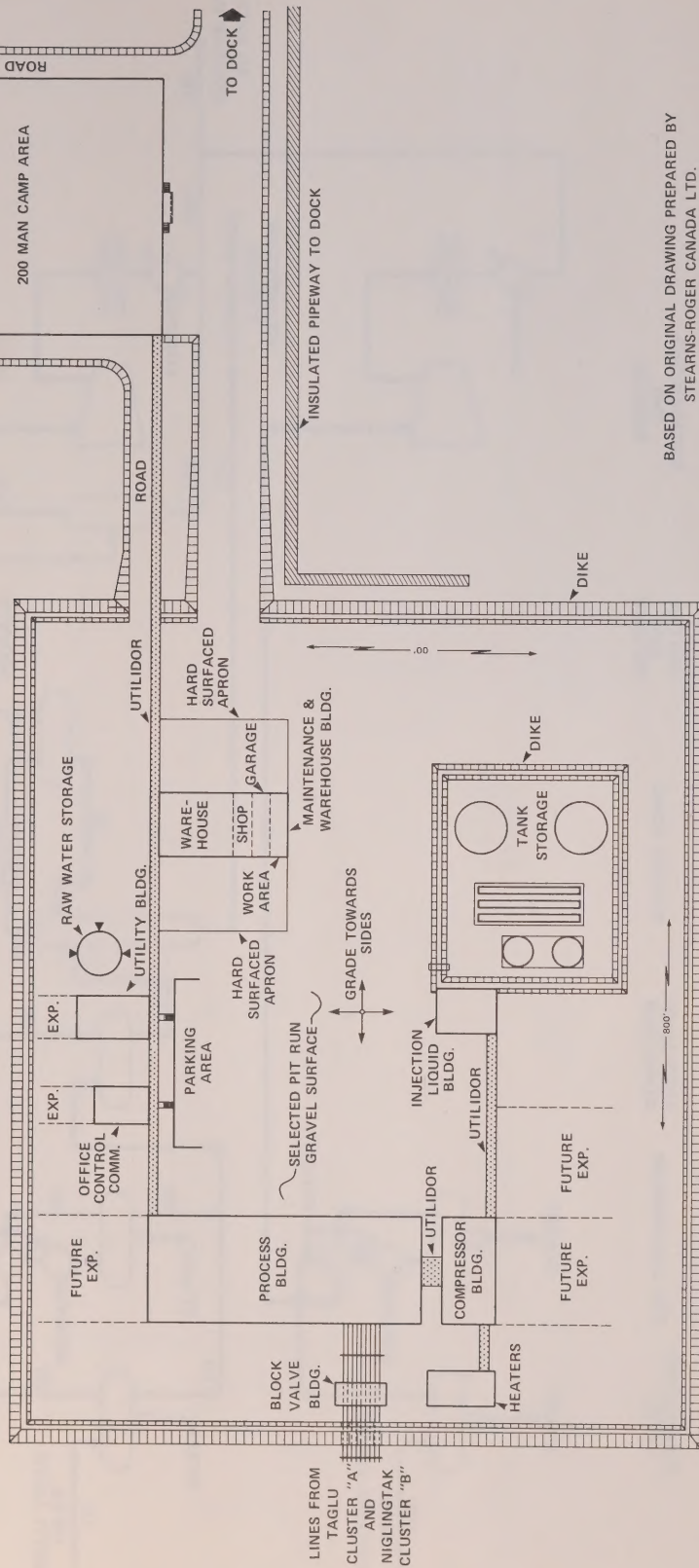
FIGURE 1
CONCEPTUAL PLOT PLAN
TAGLU GAS PLANT



APPROX. SCALE: 1" = 800'

BASED ON ORIGINAL DRAWING PREPARED BY
STEARNS ROGER CANADA LTD.

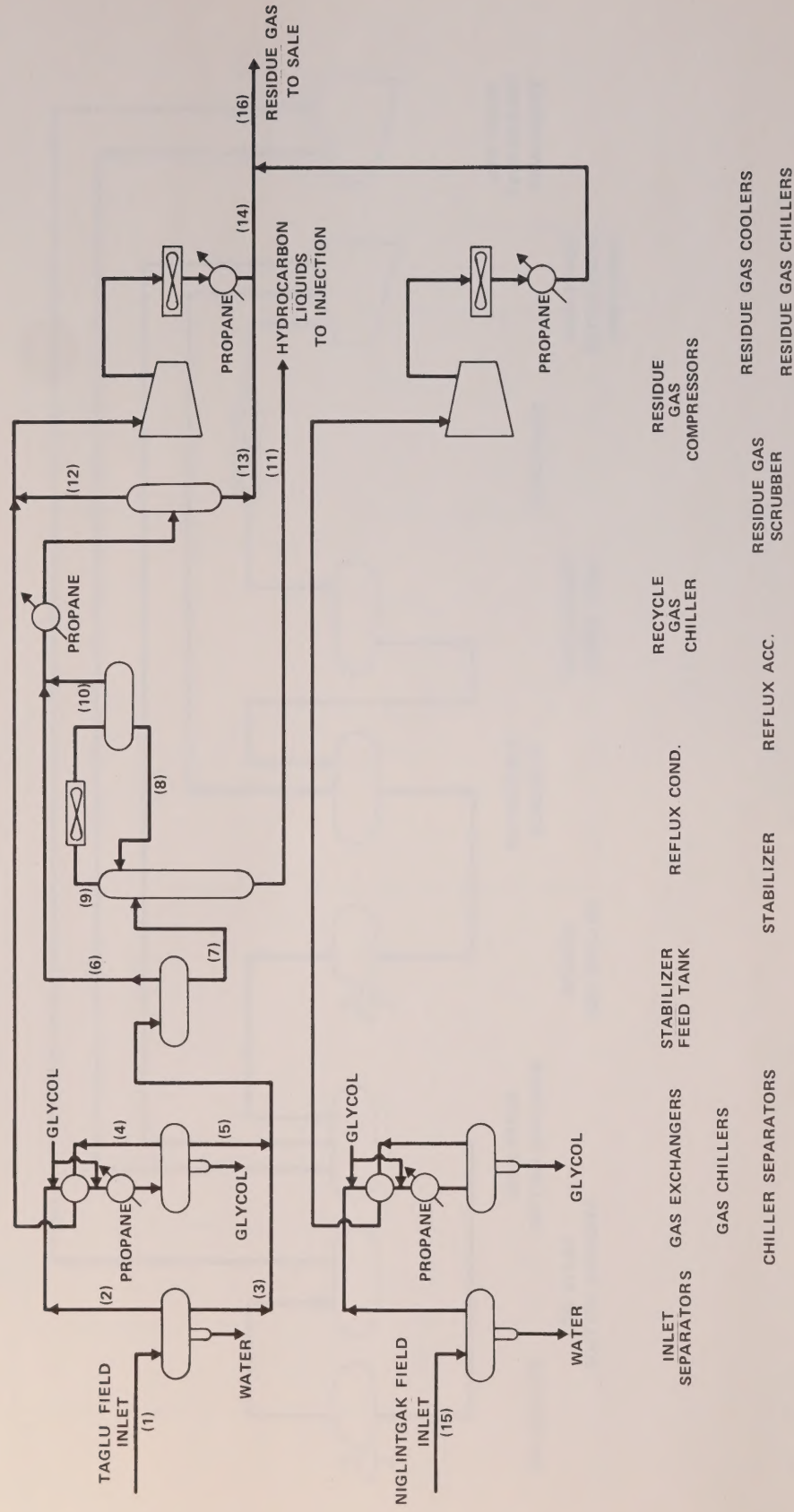
FIGURE 2
CONCEPTUAL LAYOUT
TAGLU GAS PLANT



BASED ON ORIGINAL DRAWING PREPARED BY
STEARNS-ROGER CANADA LTD.

APPROX SCALE: 1" = 150'

MAIN PROCESS FACILITIES TAGLU GAS PLANT



NUMBERS REFER TO MATERIAL BALANCE IN TABLE 2

FIGURE 4

TYPICAL REFRIGERATION FACILITIES

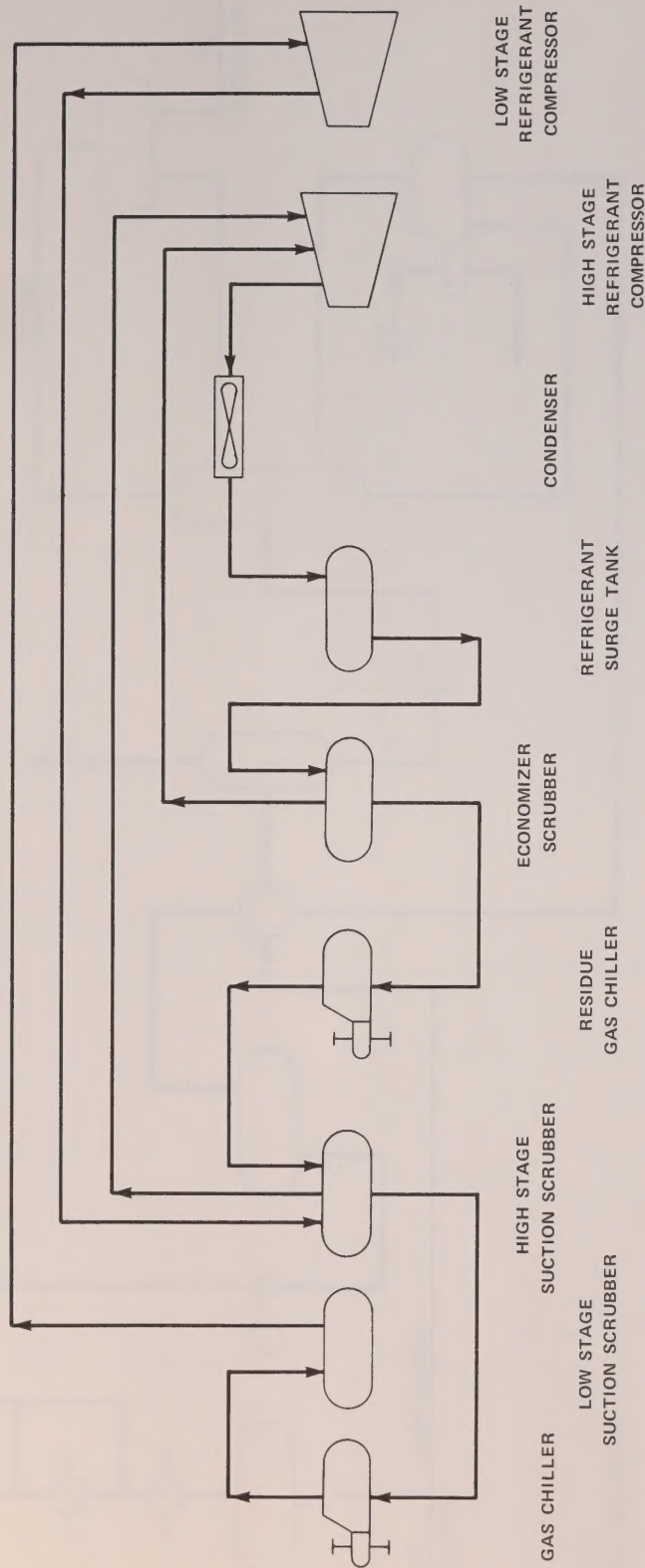
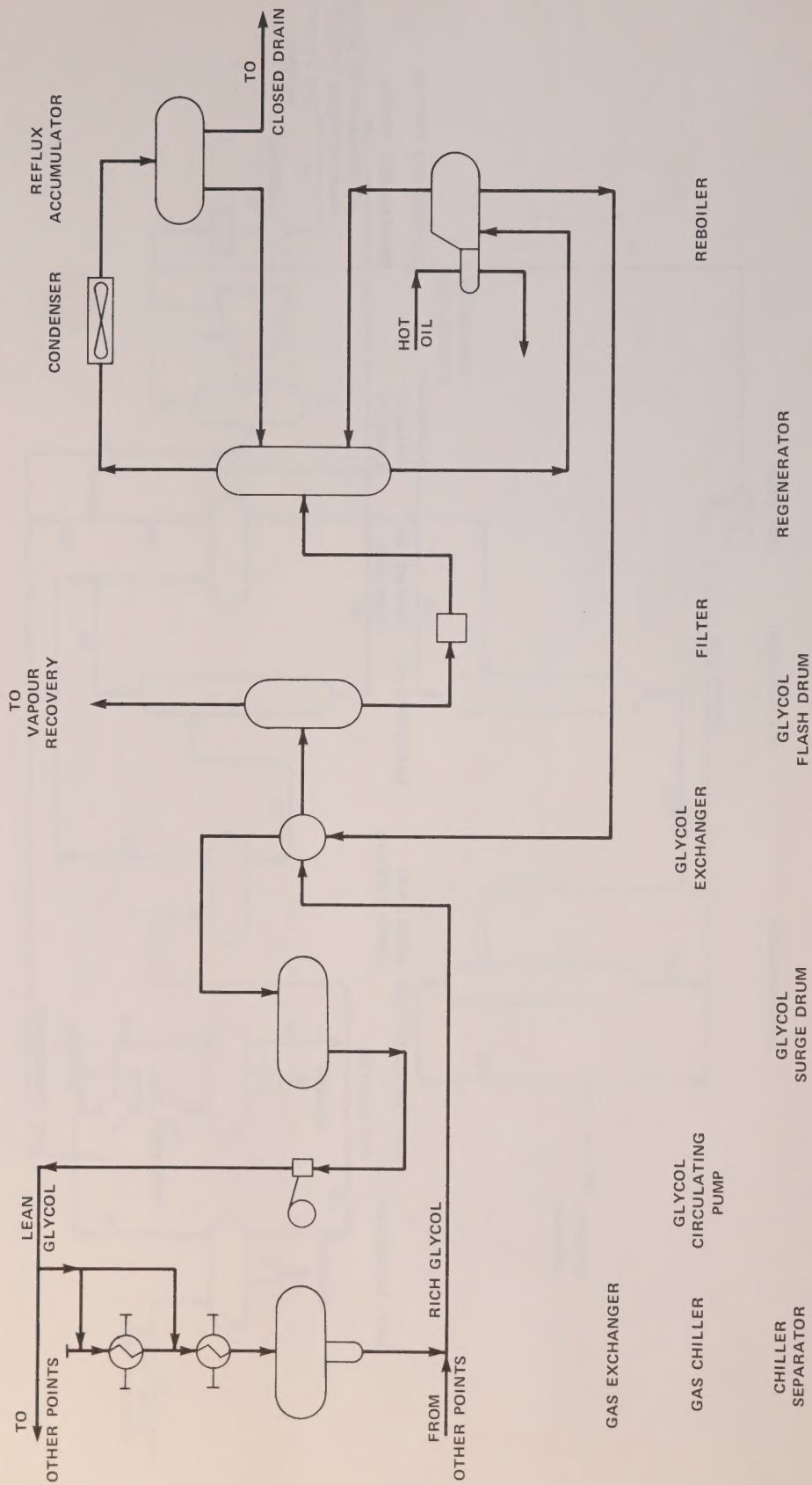


FIGURE 5

TYPICAL GLYCOL REGENERATION FACILITIES



MAIN PROCESS FACILITIES PARSONS LAKE PLANT

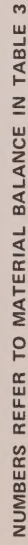


FIGURE 7

OCEAN BARGE ROUTES

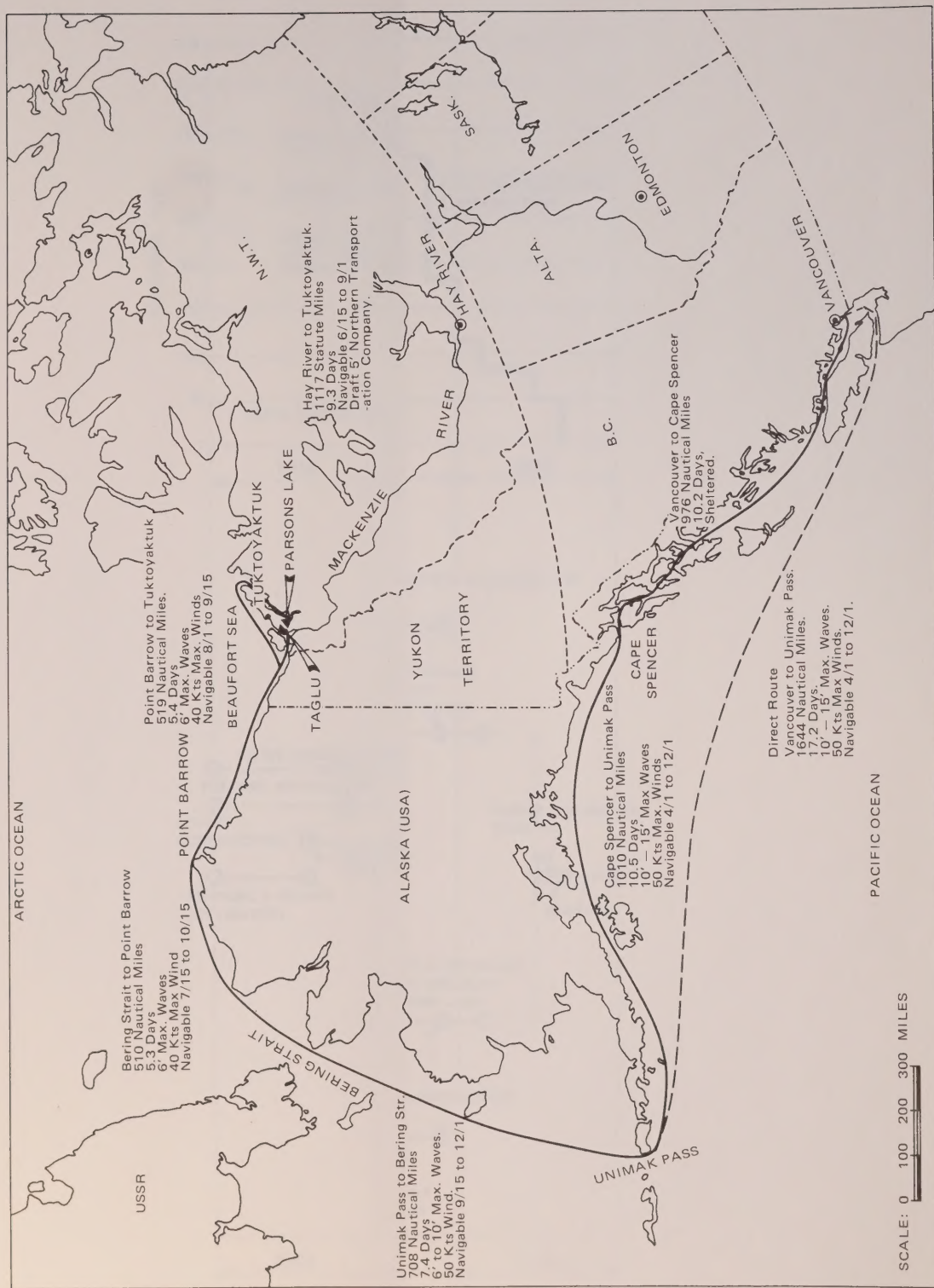
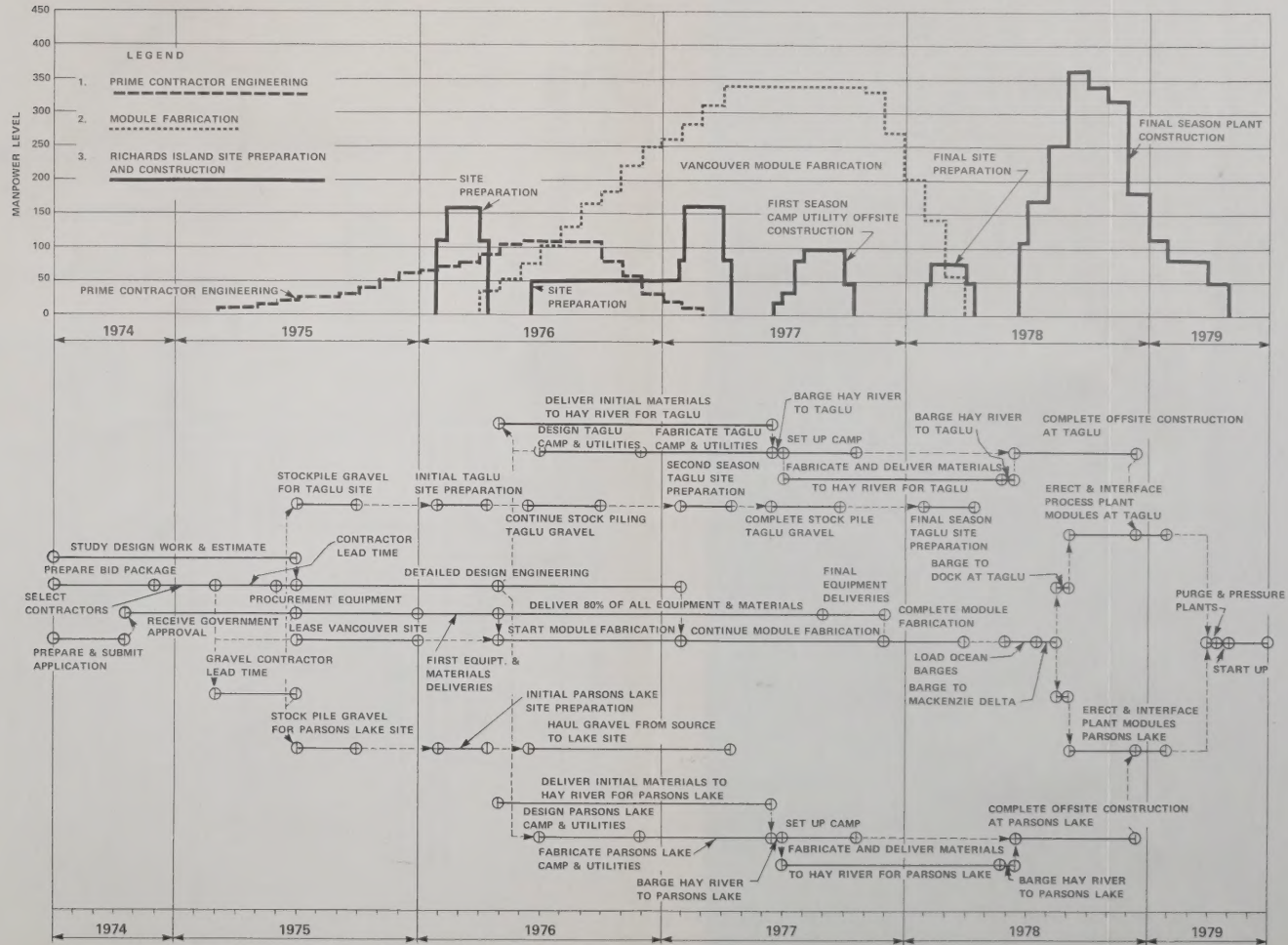


FIGURE 8
CONSTRUCTION SCHEDULE AND MANPOWER ESTIMATE TAGLU AND PARSONS LAKE PLANTS



BASED ON ORIGINAL DRAWING PREPARED BY STEARNS-ROGER CANADA LTD.

FIGURE 9
LIVING QUARTERS CONCEPTUAL PLAN

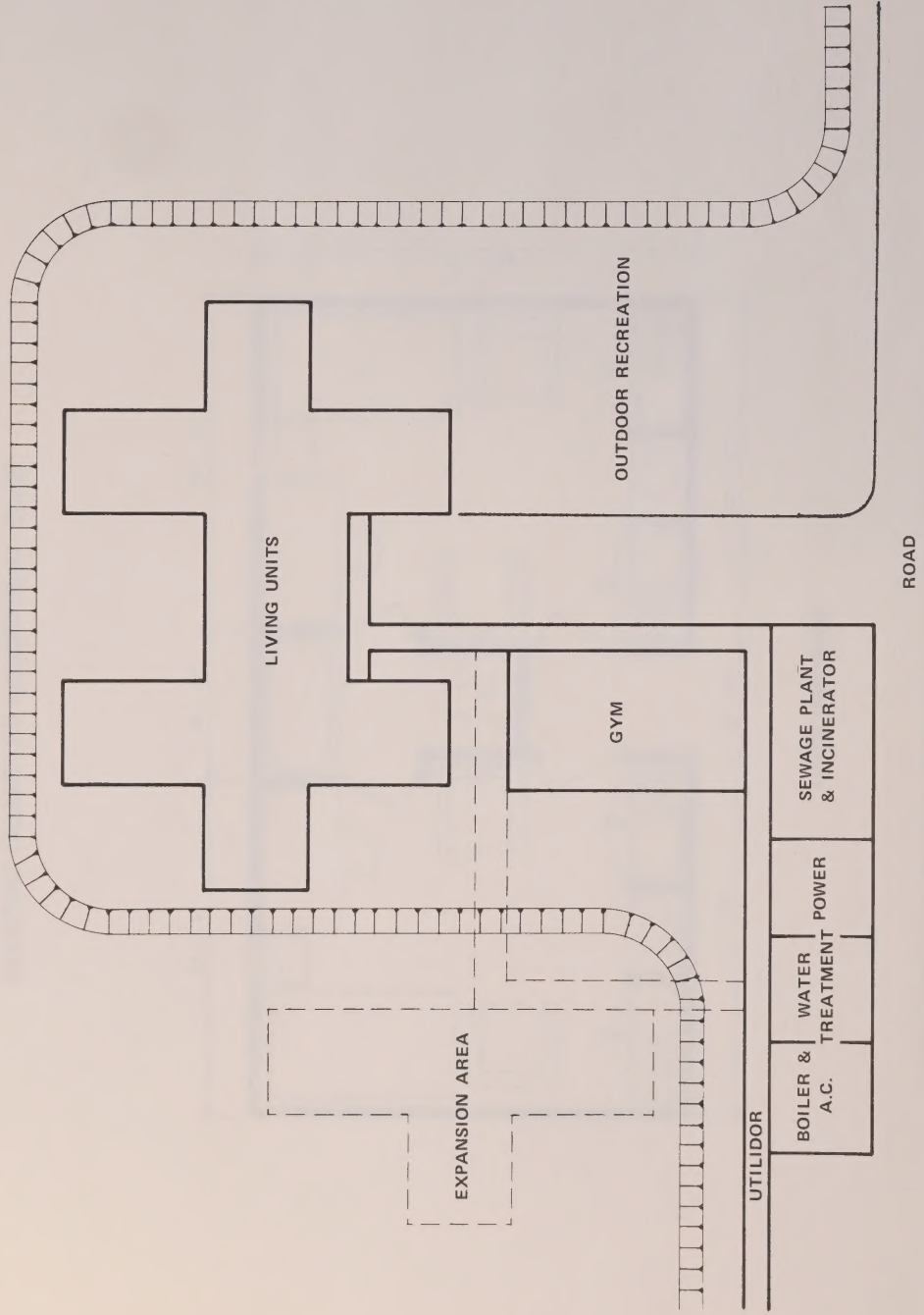
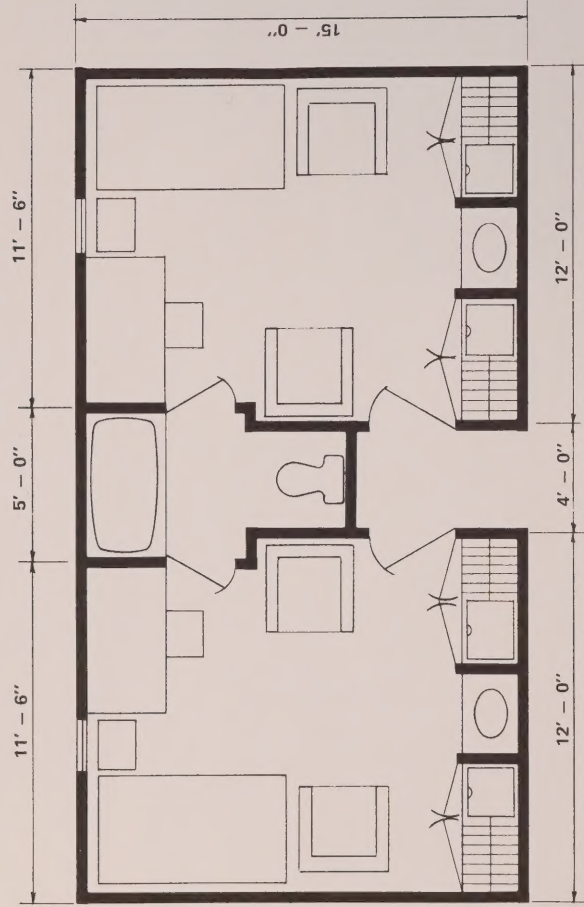


FIGURE 10
SLEEPING QUARTERS CONCEPTUAL PLAN



LIVING UNIT PLAN

